

Cisco 3600 Series Performance Guidelines

Introduction

This Product Bulletin covers the following areas:

- Basic performance characteristics
- Network module configuration table
- Network module memory requirements
- Performance capabilities
- Asynchronous transfer mode (ATM) OC-3 Network Modules
- Cisco IOS® performance guidelines
- Scatter/gather buffer allocation scheme

Basic Performance Characteristics

Table 1 Cisco 3600 Hardware Overview

Feature	Cisco 3620	Cisco 3640	Cisco 3660
Processor Speed	80MHz RISC	100MHz RISC	225MHz RISC
System Capacity	150 Mbps	250 Mbps	320 Mbps
Fast Switching	20 - 40 kpps	50 - 70 kpps	100 - 120 kpps
Process Switching	2 kpps	4 kpps	11 - 12 kpps

Network Module Compatibility Chart

Table 2 describes the maximum number of each network modules supported and the minimum Cisco IOS release required to support it.

Table 2 Cisco 3600 Series Network Module Configurations Table

Network Module	Cisco 3620 max	Cisco 3640 max	Cisco 3660 max	Minimum IOS Version
NM-1E2W	2	4	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: 12.0(5)T
NM-2E2W	2	4	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: 12.0(5)T
NM-1E1R	2	4	6	Cisco 3640/3620: 11.1(8+)AA Cisco 3660: 12.0(5)T
NM-1E	2	4	6	Cisco 3640/3620: 11.2(4)XA Cisco 3660: 12.0(5)T
NM-4E	2	3	6	Cisco 3640/3620: 11.2(6)P Cisco 3660: 12.0(5)T
NM-1FE-TX	2	3	4 ¹	Cisco 3640/3620: 11.2(6)P Cisco 3660: 12.0(5)T
NM-1FE-FX	2	3	4 ¹	Cisco 3640/3620: 11.2(10)P Cisco 3660: 12.0(5)T
NM-1FE-1CT1 NM-1FE-1CT1-CSU	2	3	4 ¹	Cisco 3640/3620: 11.3(4)T or later Cisco 3660: 12.0(5)T.
NM-1FE-2CT1 NM-1FE-2CT1-CSU	2	3	4 ¹	Cisco 3640/3620: 11.3(4)T or later Cisco 3660: 12.0(5)T
NM-1FE-1CE1B NM-1FE-1CE1U	2	3	4 ¹	Cisco 3640/3620: 11.3(4)T or later Cisco 3660: 12.0(5)T
NM-1FE-2CE1B NM-1FE-2CE1U	2	3	4 ¹	Cisco 3640/3620: 11.3(4)T or later Cisco 3660: 12.0(5)T
NM-4T	2	3	6	Cisco 3640/3620: 11.2(4)XA Cisco 3660: 12.0(5)T
NM-16A	1	3	6	Cisco 3640/3620: 11.2(7)P Cisco 3660: 12.0(5)T
NM-32A	1	3	6 ²	Cisco 3640/3620: 11.2(7)P Cisco 3660: 12.0(5)T
NM-4A/S	1	3	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: 12.0(5)T
NM-8A/S	1	3	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: 12.0(5)T
NM-4B-U	1	3	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-8B-U	1	3	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-4B-S/T	1	3	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-8B-S/T	1	3	6	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-1CT1	1	3	5	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-1CT1-CSU	1	3	5	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-2CT1	1	3	5	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000

Table 2 Cisco 3600 Series Network Module Configurations Table (Continued)

Network Module	Cisco 3620 max	Cisco 3640 max	Cisco 3660 max	Minimum IOS Version
NM-2CT1-CSU	1	3	5	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-1CE1B	1	3	5	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-1CE1U	1	3	5	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-2CE1B	1	3	5	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
NM-2CE1U	1	3	3	Cisco 3640/3620: 11.1(7+)AA Cisco 3660: Q1CY2000
AIM-COMPR4	0	0	2	Cisco 3660: 12.0(5)T
NM-COMPR	1	1	0	Cisco 3640: 11.2(7)P
NM-6D-MODEM	1 ³	2	5	Cisco 3640: 11.2(9)XA Cisco 3660: Q1CY2000
NM-12D-MODEM	1 ³	2	5	Cisco 3640: 11.2(9)XA Cisco 3660: Q1CY2000
NM-18D-MODEM	1 ³	2	4	Cisco 3640: 11.2(9)XA Cisco 3660: Q1CY2000
NM-24D-MODEM	1 ³	2	4	Cisco 3640: 11.2(9)XA Cisco 3660: Q1CY2000
NM-32D-MODEM	1 ³	2	4	Cisco 3640: 11.2(9)XA Cisco 3660: Q1CY2000
NM-HDV-1T1-24	1	3	6	12.0(5)XK, 12.0(6)T or later
NM-HDV-1T1-24E	1	3	6	12.0(5)XK, 12.0(6)T or later
NM-HDV-1T1-48	1	2	6	12.0(5)XK, 12.0(6)T or later
NM-1ATM-25	1	2	TBD	Cisco 3640/3620: 11.3(3a)T or later Cisco 3660: Q1CY2000
NM-1A-OC3MM	1	1	2	Cisco 3640/3620: 12.0(3)T or later Cisco 3660: 12.0(5)T or later
NM-1A-OC3SMI	1	1	2	Cisco 3640/3620: 12.0(3)T or later Cisco 3660: 12.0(5)T or later
NM-1A-OC3SML	1	1	2	Cisco 3640/3620: 12.0(3)T or later Cisco 3660: 12.0(5)T or later
NM-4T1-IMA	1	3	6	Cisco 3600 Series: 12.0(5)T or later
NM-4E1-IMA	1	3	6	Cisco 3600 Series: 12.0(5)T or later
NM-8T1-IMA	1	3	6	Cisco 3600 Series: 12.0(5)T or later
NM-8E1-IMA	1	3	6	Cisco 3600 Series: 12.0(5)T or later

1. The Cisco 3660 will support 4 NM-1FE-TX/FX modules if the internal FE interfaces are not used.

2. Requires 128 MB of SDRAM

3. With any of these modules installed: NM-1FE1CT1, NM-1FE1CT1-CSU, NM-1FE2CT1, NM-1FE2CT1-CSU, NM-1FE1CE1B, NM-1FE1CE1U, NM-1FE2CE1B, and NM-1FE2CE1U

Network Module Memory Requirements

The amount of packet memory required is dependent on the number and type of network module configured, but is also dependent on the amount of memory required by the Cisco IOS software for each specific feature enabled. For example, the CT1 requires much more memory (both processor and packet) when configured for Integrated Services Digital Network (ISDN), than when configured for T1 or E1 channelized mode.

- The following equation is used to determine the amount of memory required for the Ethernet private pool of buffers:
 - Number of buffers in the private pool = 3 x number of buffers in the receive ring
 - Number of cache entries for the private pool = number of buffers in the receive ring
- The Ethernet interface requires 32 descriptors per interface, with a maximum transmission unit (MTU) of 1524, that is $(32 \times 1.5K) \times 3 = 144K$ per interface.
- The serial interface requires that two 18 K frames (maximum MTU allowed) be allocated with a buffer particle size of 512 bytes, which means $(18K/0.5) \times 2 = 72$ descriptors are required. Therefore $(72 \times 0.5) \times 3 = 108K$ of memory is required per interface.
- The Token Ring interface is required to store four 8 K frames. The required number of descriptors with 512-byte particles is $(8K/0.5) \times 4 = 48$. Therefore, 64K memory is required per interface.
- The synchronous/asynchronous NM has 2 IDBs per interface, or 10K per interface. Rx buffers are created for both synchronous and asynchronous modes.
- Synchronous mode requires $12 \times (MTU/1536)$ buffers or $12 \times MTU$ KB per interface.
- Asynchronous mode requires 5×1524 buffers per port or 7.4 kb per port, therefore, the total memory required per port is: IDB + Rx buffers = $10K + 12 \times MTU + 7.4$ kb per port.
- In asynchronous PPP mode, the Rx buffers are allocated from the public pool. Table 3 lists various combinations for network module types.

Table 3 Memory Requirements for Various Combinations

Network Module	Minimum Memory Required
NM-16A	0.4 MB
NM-32A	0.8 MB
NM-1FE-TX	0.4 MB
NM-1FE-1CT1, NM-1FE-1CT1-CSU	2.48 MB
NM-1FE-2CT1, NM-1FE-2CT1-CSU	3.68 MB
NM-1FE-1CE1B, NM-1FE-1CE1U	2.82 MB
NM-1FE-2CE1B, NM-1FE-2CE1U	4.35 MB
NM-COMP	0.78 MB
NM-4E	0.7 MB
NM-4T	0.3 MB
NM-1E	0.2 MB
1E	0.2 MB
2E2T	514K
1E2T	360K
2E1T1B	522K
1E1T1B	378K
1E1R2T	432K

Network Module	Minimum Memory Required
1E1R1T1B	450K
1 CT1	2.6 MB
2 CT1	4.4 MB
3 CT1	6.2 MB
4 CT1	8.0 MB
5 CT1	9.8 MB
6 CT1	11.6 MB
1 CE1	3.0 MB
2 CE1	5.4 MB
3 CE1	8 MB
4 CE1	10.2 MB
5 CE1	12.5 MB
6 CE1	15.0 MB
8B	2.2 MB
4B	1.1 MB
8 A/S	0.6 MB
4 A/S	0.3 MB

Table 4 Detailed CT1 Network Module Processor and I/O Memory Breakdown

Network Module	Processor Memory	I/O Memory
First 2-Port Channelized T1	875K	400K
Each Additional 2-Port CT1	75K	400K
First 2-Port T1 PRI	1927K	2600K
Each Additional 2-Port PRI	1100K	2600K
2 CT1 - No Configuration	826K	0.6K
4 CT1 - No Configuration	847K	0.6K
6 CT1 - No Configuration	866K	0.6K
2 CT1 1 Channel 24 Timeslots	850K	160K
2 CT1 2 Channel 24 Timeslots	875K	315K
4 CT1 4 Channel 24 Timeslots	946K	725K
6 CT1 6 Channel 24 Timeslots	1017K	1137K
2 CT1 1 Full PRI	1382K	1184K
2 CT1 2 Full PRI	1927K	2566K
4 CT1 3 Full PRI	2473K	3829K
4 CT1 4 Full PRI	3012K	5103K
6 CT1 6 Full PRI	4112K	7754K

ISDN Memory-Sizing Errors

The router error message `SYS-2-MALLOCFAIL` is a shared memory allocation failure, indicating that insufficient packet memory is available for the network modules installed. This error will occur when less than 1.2 MB of free `iomem` is available for use. If this error is seen, increase the memory-size `iomem` percentage or the DRAM.

At least 2 MB of free processor memory and 1.2 MB of free I/O memory are required for most normal-sized networking applications. Customers can use the Cisco IOS software command `show memory free` to verify the amount of available processor and I/O memory.

Performance Capabilities

The Cisco 3660 router supports up to 6 network modules, the Cisco 3640 router supports up to 4 network modules, and the Cisco 3620 router supports up to 2 network modules. The Combo Port Module (CPM) supports 1 or 2 fixed LAN interfaces and 2 user configurable WAN interfaces. The fixed LAN interfaces provide support for 2E and 1E configurations in the initial release and a later 1E1R (1 Ethernet, 1 Token Ring) configuration. The WAN interface supports Cisco 5-in-1 high-speed serial, or basic rate interface (BRI) with S/T, or U interface in the initial release. The WAN interfaces are small user-installable daughter cards that can be inserted into the customer provide equipment (CPM).

1/2 PRI/E1 Network Port Module

The total aggregate throughput performance of the 2 port primary rate interface (PRI)/CE1 network module is 16 kpps. Use Cisco IOS CPU-intensive features such as Multilink and compression with more than 1 PRI configured with caution if traffic loads above 40 kbps per channel are expected.

4/8B Network Port Module

With all 8 BRI ports running continuous data (144 kbps each) and 50-byte packets, the maximum performance possible is 5760 pps and an aggregate data rate of 2.3 Mbps full-duplex. Maximum loading of all 24 BRI ports should not be an issue unless the use of Cisco IOS software features that are CPU intensive are configured.

4 and 8 Synchronous/Asynchronous

The 4/8 A/S Network Processing Module (NPM) provides low-speed connectivity for both asynchronous and synchronous interfaces. Each port supports up to 128 kbps full duplex in synchronous mode and 115.2 asynchronous.

For synchronous mode, the packet transfer rate for each port is 250 pps with 64-byte packets at 128 kbps. The combined throughput for the Cisco 3640 router with 24 serial ports is about 6 kpps. Any limitations in performance mainly result from system interrupt latency rather than the available bus bandwidth.

For asynchronous mode, the maximum port speed is 115.2 kbps uni-directional with 10 percent in the opposite direction. Again, the performance depends largely on interrupt latency. The higher number of interrupts pending to service at the time is the limiting factor of how many async ports can be serviced under worst-case conditions. Real life applications where all ports require servicing at the same time should be rare.

1E and 4E Network Port Modules

The Cisco 3620 router supports two 1E NPMs per chassis, the Cisco 3640 supports up to four 1E NPMs per chassis, the Cisco 3660 supports up to six 1E NPM. The Cisco 3620 supports a maximum of one 4E NPM, and the Cisco 3640 can support up to a maximum of three 4E NPMs per chassis and the Cisco 3660 can support up to six 4E NPMs.

4T Network Port Module

The Cisco 3620 is capable of supporting 2 4T NPMs per chassis. The Cisco 3640 is capable of supporting up to four 4T NPMs per chassis. The Cisco 3660 is capable of supporting up to six 4T NPMs per chassis. The aggregate performance per 4T NPM is 8 Mbps. It can support 8 Mbps full-duplex on port 0 when no other port is in use, 4 Mbps full duplex on ports 0 and 2, when ports 1 and 3 are unused, and up to 2 Mbps full duplex on all 4 ports simultaneously.

56K DSU WAN Interface Card

There are no performance restrictions on the 56K DSU WIC. A maximum of 12 are supported in the Cisco 3660, 8 are supported in the Cisco 3640, and 4 in the Cisco 3620 router.

1FE-TX Network Port Module

The single-port Fast Ethernet Network Module can support 10 or 100 Mbps connections. Speed and duplex auto-negotiation is supported and if the remote device does not support auto-negotiation then we will auto-sense the speed and default to half-duplex. Manual configuration of full-duplex operation is also supported. There is no MII connector on this module. Later versions of Fast Ethernet modules will support MII.

The Fast Ethernet module can be plugged into any slot in the chassis, but when two Fast Ethernet modules are configured optimum performance is achieved when the following combinations are used: slots 0 and 1, slots 0 and 3, slots 2 and 3, and slots 1 and 2. Avoid placing 2 Fast Ethernet modules in slots 0 and 2 or slots 1 and 3 since they would be located on the same PCI bridge.

The following rules apply for multiple Fast Ethernet modules and combinations of NM-4E network modules:

- Maximum of 4 Fast Ethernet port Modules per Cisco 3660 if the internal Fast Ethernet interfaces are not used
- Maximum of 3 Fast Ethernet Port Modules per Cisco 3640 and 2 per Cisco 3620
- Do not support 2 Fast Ethernet plus 2 NM-4E network modules in a Cisco 3640
- Do not support 3 Fast Ethernet plus 1 NM-4E network module in a Cisco 3640
- Do not support 1 Fast Ethernet plus 3 NM-4E network modules in a Cisco 3640

Performance on the Cisco 3600 series has improved in IOS versions 11.2. For Fast Ethernet with 64 byte IP packets: 60 kpps full-duplex and 30 kpps for inter-switch link (ISL). On the Cisco 3620 with 64 byte IP packets: 20 kpps full-duplex and 15 kpps for ISL.

Hardware Compression

The new compression module supports link-layer compression in a single-slot of a Cisco 3640 or Cisco 3620 and has no external LAN or WAN ports. The Cisco 3660 can support up to two Advanced Integration Modules (AIM) for hardware compression. It supports compression on all serial, ISDN, and channelized T1/E1 WAN interfaces, but is not supported on asynchronous interfaces. The Cisco 3660 supports up to an aggregate speed of up to 4 E1s full duplex of compression, the Cisco 3640 supports up to an aggregate speed of up to 2 E1's full duplex of compression, and the Cisco 3620 supports up to a single T1's bandwidth. With a 2:1 average compression ratio this translates to 16 Mbps of aggregate uncompressed data. With Hardware Compression you can support up to 4 T1/E1 PRI in a network where all 128 B channels are not fully loaded simultaneously.

The Compression module uses the industry standard STAC (QIC-122) and only supports PPP encapsulation at this time. Later IOS releases will support Frame Relay, and MultiLink Point-to-Point Protocol (MLPPP), but no plans for High-Level Data Link Control (HDLC), switched multimegabit data service (SMDS), X.25 or LAPB support.

Enhanced PRI/FE Network Modules including: NM-1FE1CT1, NM-1FE1CT1-CSU, NM-1FE2CT1, NM-1FE2CT1-CSU, NM-1FE1CE1B, NM-1FE1CE1U, NM-1FE2CE1B, and NM-1FE2CE1U

There are no software limitations on the number of these new enhanced network modules that may be configured in either the Cisco 3640 or Cisco 3620. Performance is limited to the maximum documented aggregate through-put of the chassis, which is 120 kpps for the Cisco 3660, 70 kpps for the Cisco 3640 and 40 kpps for the Cisco 3620. There is also no software restrictions placed on the number of Fast Ethernet interfaces that may run in full-duplex mode, but more than one is not recommended and may not be supported if traffic rates exceed the documented performance.

The Cisco 3620 is now capable of providing hybrid ISDN/analog dial access with 24/30 digital modems when one of these modules is installed. The Cisco 3640 is now capable of supporting 8 T1/E1 PRI interfaces in a single chassis.

16/32 Asynchronous Network Modules

The 16- or 32-port Asynchronous modules requires a single slot in the Cisco 3660, Cisco 3640 or Cisco 3620. Each port supports speeds up to 134 kbps. In the Cisco 3660 up to 192 dial-up connections are supported with six 32-port modules. In the Cisco 3640 up to 96 dial-up connections are supported with three 32-port modules. All 96 ports can simultaneously support up to 115.2 kbps half duplex, with a CPU utilization greater than 90 percent. The Cisco 3620 supports one 16- or 32-port module, with 32 simultaneous 115.2 kbps full duplex connections, and a CPU utilization greater than 90 percent.

Digital Modem Network Modules

The following new network modules are available for the Cisco 3660 and Cisco 3640: the NM-6DM, NM-12DM, NM-18DM, NM-24DM, and the NM-30DM, with 6, 12, 18, 24, and 30 digital modems preinstalled, respectively. With the integration of Modem ISDN Channel Aggregation (MICA™) technology, the Cisco 3660 can support up to 120 analog modem calls and ISDN B channels over a single dial-in telephone number and the Cisco 3640 can support up to 60 analog modem calls and ISDN B channels over a single dial-in telephone number.

The new digital modem network modules work in conjunction with the single or dual PRI network modules (rev 3) to support up to 30 modems per network module at packet sizes of 256 bytes or larger. Two digital modem network modules in the same Cisco 3640 chassis will support up to 60 concurrent sessions at wire speeds and four digital modem network modules in the same Cisco 3660 chassis will support up to 120 concurrent sessions at wire speeds.

The new digital modems support all current V.34 modem technologies with speeds up to 33.6kbps at First Customer Shipment (FCS), plus the Rockwell/Lucent K56Flex protocol via a software upgrade in Q198.

Each digital modem network module supports up to 5 Hex MICA Modem modules (HMM) with 6 modems per HMM. The HMMs consist of 3 Digital Signal Processors (DSPs), a communications processor, an Application-Specific Integrated Circuit (ASIC), and RAM (DRAM and SRAM).

MICA modems are digital modems without any RS-232 signals or DTE/DCE interfaces. The DSP provides the PCM to linear conversion, while the communication processor provides the PPP framing.

A synthesized time-division multiplexing (TDM) bus is used to transfer an incoming voice call, generated by a analog modem, from the PRI network module to the modem board. Where the DSP converts the input DS0 stream coming into a modem to an analog stream, so that the modem can retract the original data out. Then the data is transferred out to the packet memory through Direct Memory Access (DMA).

The digital modems are able to support up to 60 concurrent modem calls at wire rate of 134 kbps with large packet sizes (1500 byte). Performance testing done a test environment using only small packets (less than 128-byte) does not support wire rates on 60 concurrent sessions.

For 48 concurrent sessions with 64-byte packets in an analog only test environment, the Cisco 3640 can handle over 130 pps/call. For 48 concurrent sessions in an ISDN only test environment, using 64-byte packets the Cisco 3640 can support over 100 pps/call.

High Speed Serial Interface (HSSI) Network Module

The NM-1HSSI network module is capable of attaining wire-rate speeds on the Cisco 3660, Cisco 3640 and Cisco 3620 platforms. This performance number is achieved with a single Fast Ethernet network module to a single NM-1HSSI network module configuration using Ethernet size IP packets with uni-directional traffic. The performance on the Cisco 3660 for 64-byte IP packets is 69kpps, on the Cisco 3640 is 44 kpps full duplex, and 37 kpps full duplex on the Cisco 3620.

The Cisco 3640 is capable of supporting up to 3 HSSI interfaces in a single chassis, with the performance restriction of 44 Mbps full-duplex aggregate throughput. If the bi-directional traffic on all three interfaces exceed 44 Mbps packet drops, underruns and overrun errors may occur. Two NM-1HSSIs is not a tested, or officially supported configuration on a Cisco 3620. Four NM-1HSSI in a Cisco 3640 is also not a supported configuration.

There are no slot placement restrictions for a single NM-1HSSI in either the Cisco 3640 or Cisco 3620. In a Cisco 3640 with two HSSI, installing both on the same PCI bridge will provide slightly better performance and reduce the risks of packet drops, underruns, or overruns in high traffic bi-directional applications. This means that if two NM-1HSSIs are configured they should be installed in slots 0 and 2, or slots 1 and 3 for optimum performance.

Table 5 FE to HSSI Benchmark Performance Tests for Half- and Full-Duplex Traffic with 11.3(5)T.

Packet Size	Traffic Type	Switching Mode	Peak Rate	Mbps
64	Unidirectional	Fast	40,500 pps	20.7 Mbps
128	Unidirectional	Fast	40,000 pps	41.0 Mbps
256	Unidirectional	Fast	22,000 pps	45.0 Mbps
512	Unidirectional	Fast	11,900 pps	48.7 Mbps
1518	Unidirectional	Fast	4,200 pps	51.0 Mbps

Packet Size	Traffic Type	Switching Mode	Max Aggregate TX+RX	Total Aggregate
64	Bidirectional	Fast	44,000 pps	22.5 Mbps
128	Bidirectional	Fast	20,225 pps	41.4 Mbps
256	Bidirectional	Fast	28,320 pps	58.0 Mbps
512	Bidirectional	Fast	18,800 pps	77.0 Mbps
1518	Bidirectional	Fast	8,235 pps	100 Mbps

FE to HSSI Benchmark Performance tests for the Cisco 3660 with 12.0(5)T.

Packet Size	Traffic Type	Switching Mode	Peak Rate (pps)	Mbps
64	Unidirectional	Fast	69,013 pps	46.4 Mbps
256	Unidirectional	Fast	24,558 pps	51.7 Mbps
512	Unidirectional	Fast	12,132 pps	51.7 Mbps
1518	Unidirectional	Fast	4,204 pps	51.7 Mbps

ATM OC-3 Network Modules

A maximum of one ATM OC-3 network module is recommended for both the Cisco 3640 or Cisco 3620, but this is not a software-enforced restriction. More than two high-speed interfaces (including ATM, FE or HSSI NMs) are not recommended in a Cisco 3640. An understanding of the Cisco 3600 Series performance considerations is recommended when an ATM OC-3 network module is configured with two or more high-speed network modules.

The OC-3 network modules are not capable of running at full wire-rate speeds on either the Cisco 3640 or Cisco 3620 routers. The ATM OC-3 network module's Fast Ethernet to ATM OC-3 performance on a Cisco 3640 with large packets is 83 Mbps. The Cisco 3620 is capable of up to 68 Mbps. Performance on the Cisco 3640 with 64 byte packets is 40Kpps, and on the Cisco 3620 it is 21Kpps with 64 byte packets.

ATM on a Cisco 3600 series router is ideal for 20 – 80 Mbps throughput requirements used in Transparent LAN Service (TLS) or Native LAN Service applications.

Table 6 IOS 12.0(3)T Performance of OC-3 Network Modules on the Cisco 3600 Series

Platform/Configuration	64-byte frames	1518-byte frames
Cisco 3660/FE-ATM	80.0 kpps (53.8 Mbps)	8.1 kpps (100 Mbps)
Cisco 3640/FE-ATM	40.8 kpps (21 Mbps)	6.8 kpps (83.4 Mbps)
Cisco 3640/ATM-ATM	27.4 kpps (13.8 Mbps)	6.7 kpps (81.4 Mbps)
Cisco 3620/FE-ATM	21.4 kpps (11 Mbps)	5.6 kpps (68 Mbps)

Cisco IOS Performance Guidelines

Under average loading situations, the Cisco 3660 is capable of supporting up to a maximum limit of 12 PRIs, the Cisco 3640 is capable of supporting up to a maximum limit of 6 PRIs and the Cisco 3620 can support 2 PRIs when using High-Level Data Link Control (HDLC) or PPP encapsulations. These maximum numbers are greatly reduced if CPU-intensive features such as Weighted Fair Queuing (WFQ), MP, and compression are implemented. The fast switching path is not used when any of these features are configured, placing a higher load on the CPU.

Weighted Fair Queuing (WFQ)

WFQ is not process-switched, but is CPU-intensive, and will cause higher CPU utilization to occur on interfaces with it enabled, than on those without. WFQ will work with PPP and can be enabled with MP, but MP will cause severe performance degradation. This is because the packets are segmented to put out on the various channels in the multilink bundle, and then the WFQ is performed. This has the effect of putting different segments of the same packet into different fair queues and has the potential to cause incorrect ordering (among other things) when the packet segments arrive at the remote end for reassembly. WFQ and MP should *not* be used together.

PPP

All 6 T1/PRI ports on the Cisco 3640 are capable of sustaining up to 138 calls, with each channel running 58 kbps bidirectionally with less than one percent packet loss at a CPU rate of ninety percent. The Cisco 3620 is capable of supporting both T1/PRI ports, with 46 calls up, and each channel running 58 kbps bidirectionally at a CPU utilization of fifty percent. T1/PRI support will be available by Q1CY2000 for the Cisco 3660.

MP

MP is process-switched in Cisco IOS Release 11.1. The Cisco 3640 router is capable of supporting 2 T1/PRI ports with 46 calls up, each channel running 24 kbps bidirectional, at a ninety percent CPU utilization. With more than 2 T1/PRI enabled, the data throughput decreases significantly, and packet loss increases. The Cisco 3620 router is capable of supporting 1 T1/PRI port with 23 calls up, at a data rate of 40 kbps bidirectional per channel, and a CPU utilization of ninety-six percent. T1/PRI support will be available by 1QCY2000 for the Cisco 3660.

Table 7 MP Performance Tests Results for Cisco 3640 in Release 11.1(7)AA

Bundles	Pkt Size	TxPPS	RxPPS	%CPU	Pkt Loss	Aggregate Throughput	Chan Throughput
5	768	96	93	93%	3%	*563,952 bps	*112,790 bps
15	768	318	314	49%	1%	*1,904,096 bps	*126,940 bps
23	128	120	120	22%	0%	*113,280 bps	*4925 bps
23	128	480	480	73%	0%	*453,120 bps	*19,701 bps
23	128	600	600	94%	0%	*566,400 bps	*24,626 bps
23	128	630	630	95%	0%	*594,720 bps	*25,857 bps
23	128	660	660	96%	0%	*623,040 bps	*27,089 bps
23	128	720	361	100%	50%	*340,784 bps	*14,817 bps
23	256	660	660	97%	0%	*1,298,880 bps	*56,473 bps
23	768	485	482	77%	1%	*2,922,848 bps	*127,080 bps

Release 11.2 Performance Improvements for MP

In Release 11.2(4)XA and above, MP performance has been increased 4 times what is seen in Release 11.1. Cisco is capable of running 4 T1 PRI up to 20 kbps per channel bidirectionally at ninety-six percent CPU. Table 6 details where performance improvements are achieved in Release 11.2.

Table 8 MP Performance Test Results for Cisco 3640 Routers in Release 11.2

Bundles	Pkt Size	TxPPS	RxPPS	%CPU	Pkt Loss	Agg Throughput bps	Chan Throughput bps
5	768	*96	*86	6%	10%	*521,504	*104,301
15	768	*331	*309	16%	7%	*1,873,776	*124,918
23	128	*623	*623	27%	0%	*588,112	*25,570
23	128	*1871	*1871	81%	0%	*1,766,224	*76,792
23	128	*2495	*2494	96%	0%	*2,354,336	*102,362
23	128	*2807	*1346	99%	52%	*1,270,288	*55,245
23	128	*1495	*1366	67%	9%	*2,688,288	*116,882
23	128	*508	*474	25%	7%	*2,874,336	*124,971

Software Compression

IOS Software Compression is process switched, and the maximum speed the router can support before the CPU reaches 100% depends on the packet size and compression ratio of the data. T1 aggregate speeds are attainable with packet sizes greater than 1000 bytes and a 2:1 compression ratio; but for 64 - 256 byte packet sizes, 384kbps is the maximum before the CPU reaches 100%.

Multilink PPP and Compression

When used together, Multilink PPP (MP) and compression will cause a significant increase in the load on the CPU. This occurs because both MP and software compression are process switched. Performance numbers will vary greatly depending on the packet size and compression ratio of the data. With large packet sizes and highly compressible data, E1 rates are possible on the Cisco 3660, T1 rates are possible on the Cisco 3640, but with smaller packet sizes, the aggregate throughput is only 256kbps. The Cisco 3620 is about half the performance seen on the Cisco 3640.

Multichassis Multilink PPP

The Cisco 3620 is capable of supporting a single PRI when configured in MMP. The Cisco 3640 router can support up to 2 PRI (46 B channels) up to 27 kbps per channel with a Cisco 4700 as the offload router.



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